FINAL DRAFT

Contract Cost Changes
On Highway Construction Projects

Presented to the Legislative Transportation Committee

January 1997

Contract cost changes on highway construction projects

Introduction:

In 1995, the Legislature directed the Department of Transportation to perform a detailed study of contract cost changes.

House Bill 2080 states:

> *"The legislature needs to determine all possible causes for changes in a project's cost from the time the cost is identified in the transportation commission's budget recommendation provided to the governor and legislature in support of the proposed highway construction budget, through completion of project construction."*

And:

> *" the department shall provide a historical data report showing changes throughout the life of selected projects. The historical data report shall quantify the reasons for project increases or decreases and include department of transportation actions taken to minimize such changes. The department is directed to assess whether construction cost efficiencies can be achieved by ensuring continuity between design efforts and construction administrative activities."*

To fulfill these expectations, the Department established the following scope of work:

1. Provide a historical data report showing changes in cost throughout the life of selected projects.
2. Quantify the reasons for project increases or decreases.
3. Identify actions to minimize such changes.
4. Assess whether construction cost efficiencies can be achieved by ensuring continuity between design efforts and construction administrative activities.

Background:

The questions surrounding the accuracy of the Department's estimates for highway construction projects are part and parcel of WSDOT's business functions. The Department has an ongoing review process and tries to learn from each experience.

Since no one single factor drives the final costs on any given project, it is important to understand the many factors affecting highway construction costs:

To name some: Inflation, the cost of money, the bidding climate or the level of competition in the marketplace, actual conditions found on site, mitigation requirements imposed by a number of local and state agencies, the availability of a trained labor force for the contractors, their current workload and the amount of time and effort spent on fine-tuning designs and estimates.

In this environment, the Department continuously faces tradeoffs: it considers additional costs compared to additional benefits, the value of completed projects to the traveling public versus the possible risk exposure to the State, the amount of control it has in light of a number of external factors, etc.

Periodic, detailed analyses like this one are necessary and important to assure both the Legislature and the Department's managers that the variances between estimated and actual costs remain within reasonable limits.

To perform this analysis and to ensure valid comparisons, the Department used all available data on projects started and completed since January 1991, the starting point for the Construction Contract Information System (CCIS). In addition, it was necessary to focus on projects that kept the one to one relationship between design and actual construction, since one of the issues raised by the Legislature was the possibility of lower variances if the design team also followed through with construction activities.

Following are the reports requested by the Legislature:

1. Historical data
   a) Design Phase
   b) Construction Phase

2. Principal causes for cost changes
   a) design changes in cost estimates
   b) construction contract changes

3. Actions taken to minimize cost changes

4. Could continuity between design and construction activities result in efficiencies?

1. Historical data

The first phase of this study was to select a representative set of projects containing the history of cost information from the time each project was initially scoped (defined) until the time the construction of each project was complete. The intent was to compile as large a list of projects as was possible for which all needed information was available. Since January 1991, all construction contracts have been entered into CCIS for tracking. An earlier report titled, "**Report on WSDOT Construction Contracts, 1990 to February 1995**" was provided to the Legislative Transportation Committee. That report listed all major contract changes with the associated reasons and causes and is based on information in CCIS.

The first step in compiling the needed information for this study was to identify all projects in the CCIS System that had been completed. This list of projects was further refined by selecting only those projects that were initiated as one design project and culminated in one construction contract. During the programming and project development phase some scoped projects are broken into multiple construction contracts because of their size, and conversely, some scoped projects are combined with others into one construction contract for better efficiency and less disruption. By eliminating these projects from the review list, valid comparisons could be made. The final list of projects compiled for this analysis consisted of the 132 projects listed in **Appendix A**.

a) Design Phase

Figure 1. represents milestones in the evolution of the final cost of a construction project. The very first cost estimates for projects are incorporated into WSDOT's Highway Systems Plan, and reflect an initial estimate, called a Project Prospectus, which is prepared for each individual project. The Project Prospectus represents an early rough estimate of all the needed elements to complete the project, including preliminary engineering, right of way acquisition, soils exploration, construction contract cost, construction engineering, sales tax, and any state force work that might be required during construction. Over time, specific projects are programmed and funded through transportation appropriations enacted by the Legislature. The project estimates are updated and, if necessary, revised as part of the programming activities. Once funded, the Design Phase results in the generation of the Plans, Specifications, and Estimate (PS&E). Typically, as projects progress from the Project Prospectus milestone through the design to the PS&E milestone, the variability of estimated cost is reduced. In other words, as the design of a project is refined and greater detail is known, the estimate for the project is also revised to reflect the latest cost estimate.

PROJECT COST MILESTONES

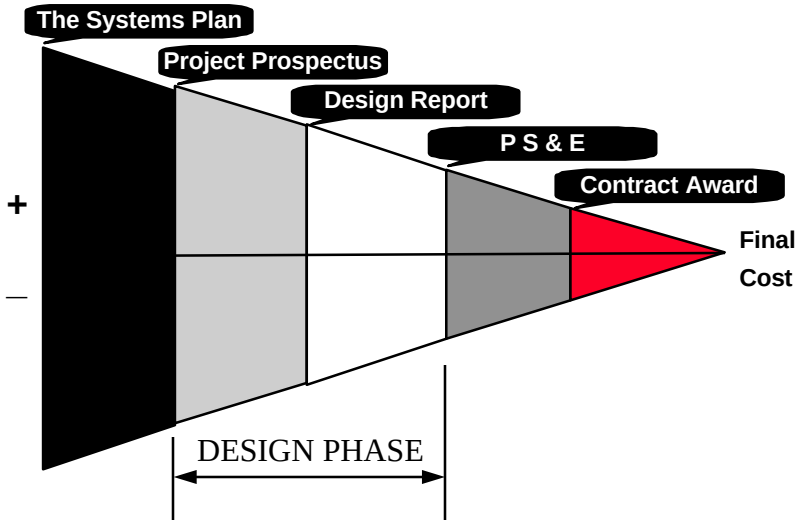

FIGURE 1.

A summary comparison of the accumulated total cost of all projects reviewed from the beginning to the end of the Design Phase, i.e., from Project Prospectus to PS&E, is presented in **Table 1**. The complete list of projects compared throughout the Design Phase is presented in **Appendix B**.

DESIGN PHASE COMPARISON SUMMARY				
PROJECTS DESIGNED BY DIFFERENT PROJECT ENGINEER				
TOTAL NUMBER	TOTAL PROSP.	TOTAL PS&E	TOTAL DIFF.	% DIFF.
OF 'PROJECTS	BOOK AMT.	ESTIMATE	PS&E VS BOOK	PS&E VS BOOK
91	115,631,994	118,638,814	3,006,820	2.6%
PROJECTS DESIGNED BY SAME PROJECT ENGINEER				
TOTAL NUMBER	TOTAL PROSP.	TOTAL PS&E	TOTAL DIFF.	% DIFF.
OF 'PROJECTS	BOOK AMT.	ESTIMATE	PS&E VS BOOK	PS&E VS BOOK
41	57,776,197	60,637,498	2,861,301	5.0%
TOTALS FOR ALL PROJECTS				
TOTAL NUMBER	TOTAL PROSP.	TOTAL PS&E	TOTAL DIFF.	% DIFF.
OF 'PROJECTS	BOOK AMT.	ESTIMATE	PS&E VS BOOK	PS&E VS BOOK
132	173,408,191	179,276,312	5,868,121	3.4%

Table 1.

These summary results indicate that the total cost of all projects included in this analysis increased 3.4% over what was identified in the initial estimate when the project was scoped. This variance indicates that, on average, the initial project estimates were reasonable and good approximations of the final design estimate, especially in light of the many independent variables which affect the costs of construction projects.

When comparing the differences between the two field offices, it was interesting to note that projects designed and built by the same field office experienced a 5.0% increase in estimated cost at the PS&E milestone, while the estimated cost of projects that were designed by one field office and passed on to another, increased only 2.6%. Given the many different causes for cost estimate increases, shown on the following pages, the difference of 2.4% is not very significant.

b. Construction Phase

Figure 2. represents the milestones in the evolution of the final cost of a project during the Construction Phase. Again, progressing toward the final project cost, the variability of estimated cost is reduced until the real project cost is known. The Construction Phase begins with the Construction Contract Cost portion of the plans, specification and estimate (PS&E). The Engineer's Estimate represents the estimate of Construction Contract Cost at the time of advertising for construction bids on the project The Bid_Amount represents the contractor's actual bid on the contract. The Final Cost represents the final payment to the contractor after contract completion.

PROJECT COST MILESTONES

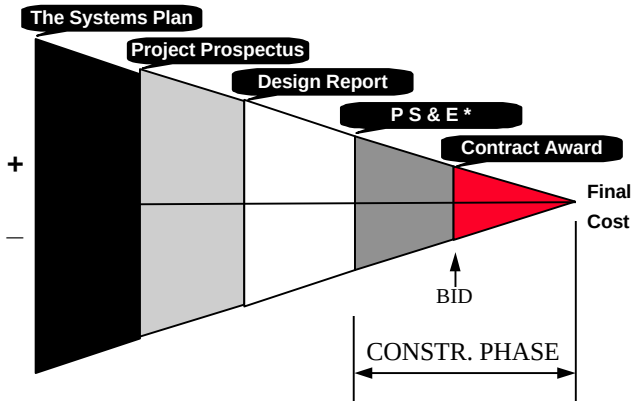

Figure 2

A summary comparison of the accumulated total cost of all projects in the Construction Phase, i.e., the last estimate of construction contract cost down to the final contract cost is presented in **Table 2**. As for the Design Phase, this table also divides the projects between projects that were designed and constructed by the same field office, and those that were constructed by field offices that had not been responsible for the design. The complete list of projects compared throughout the Construction Phase is presented in **Appendix C**.

CONSTRUCTION PHASE COMPARISON SUMMARY						
PROJECTS ADMINISTERED BY DIFFERENT PROJECT ENGINEERS						
TOTAL NUMBER	TOTAL	TOTAL	% DIFF	TOTAL	% DIFF	% DIFF
OF PROJECTS	ENGR'S EST.	BID AMT.	BID VS. EST.	FINAL COST	FINAL VS. BID	FINAL VS. EST.
91	94,729,249	82,873,851	-12.5%	87,070,289	5.1%	-8.1%
PROJECTS ADMINISTERED BY SAME PROJECT ENGINEERS						
TOTAL NUMBER	TOTAL	TOTAL	% DIFF	TOTAL	% DIFF	% DIFF
OF PROJECTS	ENGR'S EST.	BID AMT.	BID VS. EST.	FINAL COST	FINAL VS. BID	FINAL VS. EST.
41	48,412,146	42,781,944	-11.6%	45,349,487	6.0%	-6.3%
TOTALS FOR ALL PROJECTS						
TOTAL NUMBER	TOTAL	TOTAL	% DIFF	TOTAL	% DIFF	% DIFF
OF PROJECTS	ENGR'S EST.	BID AMT.	BID VS. EST.	FINAL COST	FINAL VS. BID	FINAL VS. EST.
132	143,141,396	125,655,794	-12.2%	132,419,776	5.4%	-7.5%

Table 2.

As reflected in the above summary, the final construction cost for all 132 contracts was 7.5% below the Engineer's Estimate amount. It is important to keep in mind that factors like inflation, the cost of money, the competition in the market place at time of bid, etc., all contribute to this variance.

Comparison of those projects that were designed and built by the same field office to those projects that were built by different field offices shows that the design field offices actually experienced greater increases in construction cost than the non-design field offices, namely a 6% increase in cost vs. a 5.1% increase in cost. However, the difference between the two approaches of less than 1% can be considered insignificant in light of the may other factors impacting construction cost changes.

2. Principal causes for cost changes

a) Design Phase

Several factors have been identified that can contribute to the variations in estimating the project cost during the design phase:

1. Unavailability or inaccuracy of information during scoping.

2. Environmental issues and permits that require design mitigation.

3. Soil conditions unknown or not anticipated at the time the project was scoped.

4. Third party agreements requiring unanticipated, added work. These costs are usually reimbursed by the third party but are none the less reflected as an increase in cost.

5. Changes in legal requirements that impact design features.

6. Changes in AASHTO Design Standards that must be met to avoid tort liability.

7. Escalation in the cost of right of way since the time of the original estimate.

While some additional up front effort by the Department could reduce the design variances to some extent, it is the opinion of the Department that additional expenditures during the design phase may not yield the offsetting benefits or savings on any given project. One major consideration for all WSDOT activities is finding and defining the balance between total risk avoidance and the benefits to be gained. To achieve higher precision in estimating may not be the most reasonable and cost effective approach when designing highway construction projects.

b) Construction Phase

WSDOT's earlier report titled, "Report on WSDOT Construction Contracts, 1990 to February 1995" provides a detailed listing by specific category for each contract change affecting costs and delivery. Analysis of all contracts tracked in the Construction Contract Information System resulted in grouping the detailed information into the following major categories:

1. **Differing site conditions (DSC):** Actual conditions encountered on the project were different than anticipated in the design. WSDOT's specifications provide for compensation to the contractor for increases in cost resulting from these differences. Normally, when DSC are encountered, the contractor experiences delay costs in

addition to increased costs to perform the work. DSC could possibly be reduced by increasing our site investigation during the project development phase, but it is questionable whether there is a cost/benefit to be realized. Additional site investigation may cost as much or more as any possible savings that could be realized by the additional investigation. One different approach to what WSDOT is currently doing could be to transfer the risk of DSC on the contractor rather than leaving it with the State. However, if that were done, contractors would include a contingency allowance in their bid to cover DSC. In cases where no such conditions are found, they could realize a windfall. In the Department's opinion, it is better to compensate a contractor for actual work performed and not for unknown or unanticipated conditions.
(This category was determined to represent 10.1% of the cost increases.)

2. **Plan Errors:** This category is assigned when a conflict is found between the plans and provisions of the contract. The increases in construction costs result from standby costs while the contractor waits for clarification, possible new design, costs to modify work already performed, costs to obtain different materials than were originally specified, costs to perform work not in the original scope of the contract, and additional costs incurred by working on the project longer than has been required by the original contract.
(This category was determined to represent 23.9% of the cost increases.)

3. **Design Change:** While plan errors deal with conflicts in the plans, a design change modifies the actual design. Design changes range from changing the features of a specific item to geometric changes caused by existing field conditions. These changes also may be due to changes in standards that occurred after award of the contract and would effect tort liability, or may be required as part of an effort to mitigate in accordance with earlier environmental commitments.
(This category was determined to represent 14.3% of the cost increases.)

4. **Requests from third parties:** Cities, Counties, or Utilities frequently request the Department to do additional work for them. Although the extra costs are reimbursed by the third party, the contract still shows an increase in total cost.
(This category was determined to represent 5.2% of the cost increases.)

5. **Administrative changes:** This category addresses changes affecting contract administration activities that do not impact the actual work, such as prevailing wages, sales tax issues, insurance, or material test methods.
(This category was determined to represent 6.7% of the cost increases.)
6. **Other:** This is considered a catch all category. All cost changes that do not fit the categories listed above, fall under this heading. The CCIS tracks and documents many other categories. Since all causes identified in these other categories only amount to very minor impacts by themselves, they have been consolidated in this item.
(This category was determined to represent 39.9% of the cost increases.)

3. Actions taken to minimize cost changes

The Department has undertaken a number of actions to minimize cost variations during the **Design Phase** and to produce a more representative estimate:

1. A **Design - Scoping study** has resulted in a much improved process for more accurate, early project scoping. The new process requires more time and effort in the early stages of a project, including early environmental involvement, to yield more accurate data for developing initial project definitions and estimates which in turn yield more accurate budget estimates. The expected results of this effort are fewer design changes as detailed plans and specifications are assembled, as well as cost savings in project development efforts.

2. Another effort to improve accuracy in the Design phase is represented by the **research project undertaken by the University of Washington** for WSDOT to improve the constructability review process. The results of that study provide for milestones throughout the design period for constructability reviews by key technical personnel including staff from the construction office who will ultimately be responsible for the construction contract. Early results of testing this process improvement indicate that significant issues can be identified and resolved during the project design phase. This revised process results in more accurate design information and also helps to keep the project on schedule.

3. In 1995, a task force was assembled to **review the existing Design Process** and propose changes to improve the efficiency and accuracy of project designs by streamlining the process. Recommendations from the task force have been implemented: Better efficiency in project design by making Olympia Service Center specialists available to Region design offices eliminating at least one review phase, reduction in the number and frequency of report documents, and focus of the project review efforts in the regions. The results are more timely and more accurate designs.

4. The **NEPA / SEPA / 404 Merger Agreement,** negotiated between WSDOT, FHWA, the Corps of Engineers, and five other State and Federal agencies, helps WSDOT to identify appropriate wetland mitigation strategies and costs earlier in the project development process. As a result, WSDOT will be able to more accurately estimate mitigation costs during the scoping process as well as the design stage of projects. The agreement was signed in June 1995.

Several actions have also been taken to minimize changes in the **Construction phase:**

1. The Department has implemented a **partnering** effort to improve communication and cooperation with contractors during construction. The partnering program helps to improve communication, identify tools for problem resolution, and facilitate timelier completion of construction.

2. A nationally recognized **inspector training program** has been developed which utilizes senior engineering technicians located within each Region and coordinated through the Olympia Service Center to train new construction inspectors. Training manuals, courses, and films were developed by these trainers to provide the new inspectors with the required know-how to be better prepared.

3. WSDOT has worked with industry to provide **Joint Training** for inspectors and contractors' personnel to improve our common understanding of what is expected in our contracts.

   Each year, WSDOT sponsors joint training with the Asphalt Paving Association of Washington to improve the knowledge and skills needed to construct better asphalt pavements.

   WSDOT has joined with AGC to provide training in erosion control practices now required by the Department of Ecology.

   WSDOT also joined with AGC in providing training and certification of Traffic Control Supervisors as required on all WSDOT contracts.

4. WSDOT has organized several **Joint Committees** in cooperation with industry groups to improve our specifications and the contract administration processes. Some examples of these are:

   AGC / WSDOT Joint Cooperative Committee.
   APAW / WSDOT Joint Task Force
   WACA / WSDOT Joint Committee

5. Implementation of a **Cost Reduction Incentive Program** that allows contractors to submit a better idea and share in the savings.

These actions can be viewed as an indication that the Department takes the challenge of working smarter and more efficiently very seriously. In addition, quality management approaches and tools for process improvements are becoming an integral part of WSDOT's day-to-day business practices and functions.

4. Could continuity between design and construction activities result in efficiencies?

The Construction Phase Comparison Summary, shown an Table 2, on page 6, reflects less than one percent difference in the total cost increase when comparing the two alternative approaches; i.e.: projects constructed by the same field office that had designed the projects vs. those that were constructed by a different field office. Actually, when the design field office constructed the project, the cost increase was 6.0% while the different field offices experienced a 5.1% increase in cost. This difference of less than 1% is rather insignificant. Based on this analysis, it is the opinion of the Department that efficiency gains by making one project field office responsible for both the design and construction of a project are not necessarily achievable. However, the Department will continue analyzing these trends. In case actual experience changes, WSDOT will rethink its current approach.

Conclusion

The analyses of the somewhat limited universe of 132 construction projects started and completed between January 1991 and December 1995 leads to the following conclusions:

1. Despite a number of variations, on average WSDOT is delivering the construction program within the costs identified to the Legislature.

2. Several factors were identified that impact the accuracy of early estimates compared to the last estimate of project costs just prior to construction. The precision of project estimates could be marginally improved by investing more resources early in the process. However, the marginal benefits of more precise estimates do not offset the additional costs required.

3. WSDOT is continuously working to improve the accuracy of project estimates to reduce the variation of costs experienced during the construction phase. Additional tools, like quality management techniques, will hopefully contribute to better results in the future.

4. Ensuring continuity between design efforts and construction administration activities apparently has no impact on cost efficiencies experienced during the construction phase. No correlation between cost changes and work assignments could be established.